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MILITARY POTENTIAL TEST OF INTERIM HIGH LEVEL CONTAINER AIRDROP SYSTEM (HLCADS)

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November 1973

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HLCADS	8	10

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The U. S. Army Natick Laboratories and the U.S. Army Airborne, Communications and Electronics Board, Fort Bragg, N.C., conducted an airdrop test on the Interim High Level Container Airdrop System for the purpose of determining the suitability of using a Confined Ballistic Cutter in a Two Stage configuration.

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19. KEY WORDS CONT'D

	LINK A	LINK B
Containers (Aircraft)	9	9
Parachutes	10	10
Low Velocity Drop	4	8
Confined Ballistic Cutter	10	10

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FOREWORD

This report of the Interim High Level Container Airdrop System (HLCADS) describes an airdrop system that was developed by US Army Natick Laboratories and the results of the Military Potential Test conducted on the system at Ft. Bragg, N.C., during the period October 23, 1973 to November 1, 1973.

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BACKGROUND

In the fall of 1972 the Air Force Developed "Charlie Brown" High Altitude Airdrop System began to experience deficiencies. The US Army Natick Laboratories was requested to review the system to determine if the systems' reliability could be improved. A study of the Confined Ballistic Cutter used in the system uncovered some design deficiencies.

1. The reefing line hole in the cutter was too small and had sharp edges that tended to cut the reefing line prematurely.

2. The arming ring required a straight pull to activate the cutter. If the ring were pulled at an angle, the cutter could not be armed.

Study of the reefed G-12D parachute system indicated an inherent characteristic to twist up during descent. Excessive twisting of the G-12D will not allow the parachute to disreef. Twisting also tends to close the canopy thus increasing its rate of descent and causing some loads to impact the ground before the cutter fires.

Natick Laboratories met with the commercial fabricator of the Confined Ballistic Cutter, Teledyne, Inc., and suggested some changes that could be made to improve its performance. NLABS bought several of the improved cutters and planned to test the system in a two stage configuration but the work effort was cancelled before any testing was performed.

From early fall 72 to April 73 NLABS was concerned with the task of developing an Interim HLCADS System which could be used to test the adequacy of the Air Force developed Parachute Altitude Recognition System (PARS) scheduled for delivery in July 73.

To test this Interim HLCADS System prior to the PARS delivery NLABS also planned to perform some testing using the Air Force Confined Ballistic Cutter (CBS) as the staging device in the system.

Before testing of the Interim HLCADS System with CBS staging was initiated an urgent message was received at NLABS in June 73 which stated that user experience with high altitude supply drops using the reefed parachute CBS indicated the reefed system was unsatisfactory. NLABS was asked by AMC for suggestions for improving the reefed system.

NLABS proposed to test the Interim HLCADS System with CBS cutter in a two stage configuration because it was known that there was a current procurement for $2,000,000 worth of CBS cutters.

This system was tested briefly at the 6511th Test Group at El Centro in July 73 and a system configuration determined for airdrop from altitudes of approximately 11,500 ft. However, additional confirmatory testing was necessary to determine gross reliability before the system could be offered to the field. Funds in the amount of 50K were requested by NLABS thru AMC from DA and/or the field for conduct of the testing. Funds were not forthcoming and NLABS was directed by AMC on 28 August 1973 to suspend all work related to the system pending receipt of funds from higher headquarters.

At a TROSCOM/AVSCOM meeting on 20 September 73 procurement problems being encountered by AVSCOM in its attempt to support the field were discussed. Since the Interim HLCADS System developed by NLABS does not require any parachutes or hardware components which are not readily available, it was proposed by AVSCOM as an alternate system to circumvent AVSCOM's procurement problems. As a result of the discussion at that meeting TROSCOM directed NLABS to reestablish the effort that had been suspended in August and funds would be obtained or reprogrammed to support the effort. It is the results of this reestablished effort that is discussed in this report.

DESCRIPTION OF THE INTERIM HLCADS

2-1. Components of System: The Interim HLCADS Airdrop System consists of the following items:

a. Two A-22 cargo bags rigged with or without the cover.

b. One standard cargo bag skid.

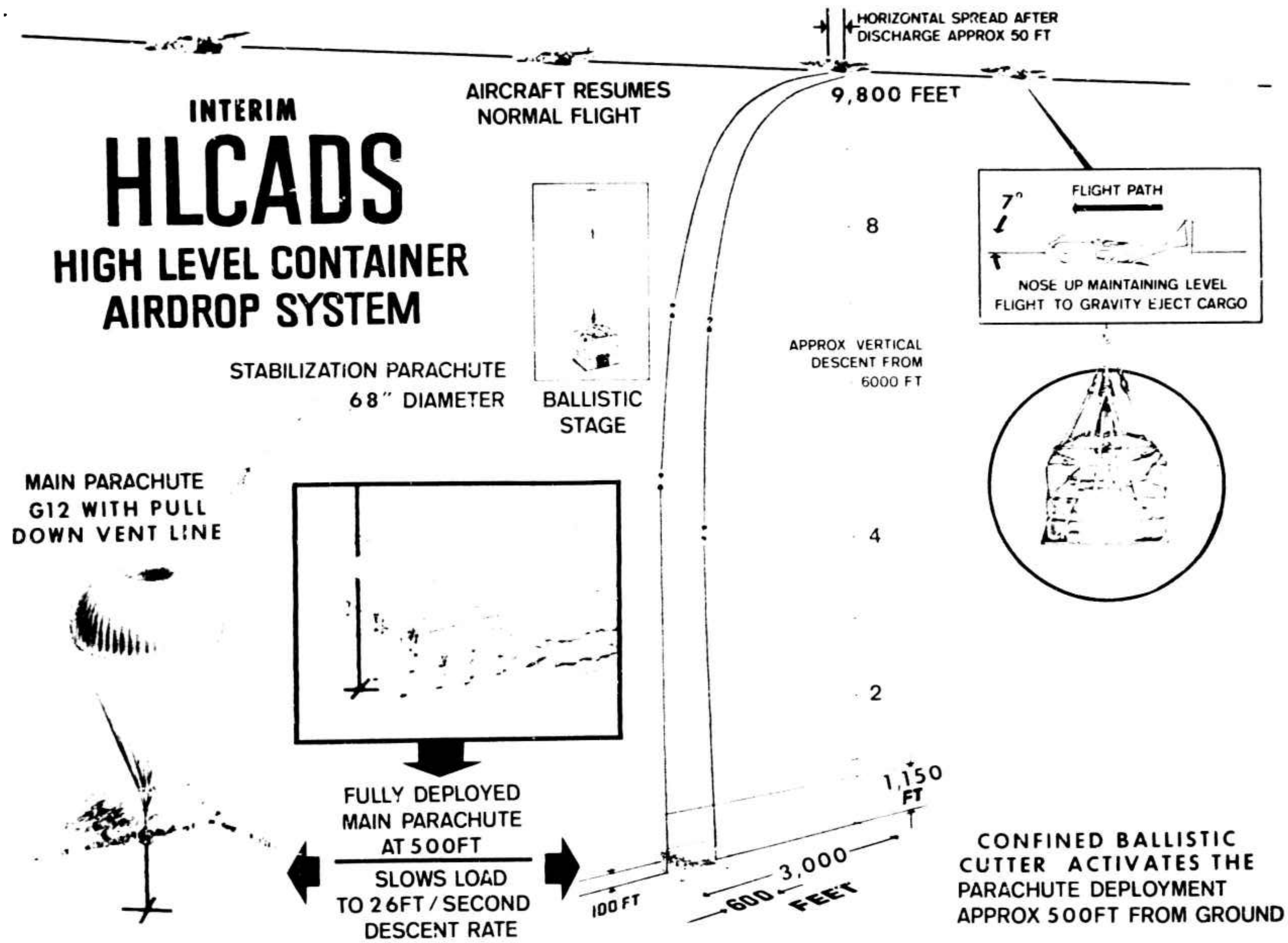
c. Two 120 inch connector strap.

d. One cutter CBS.

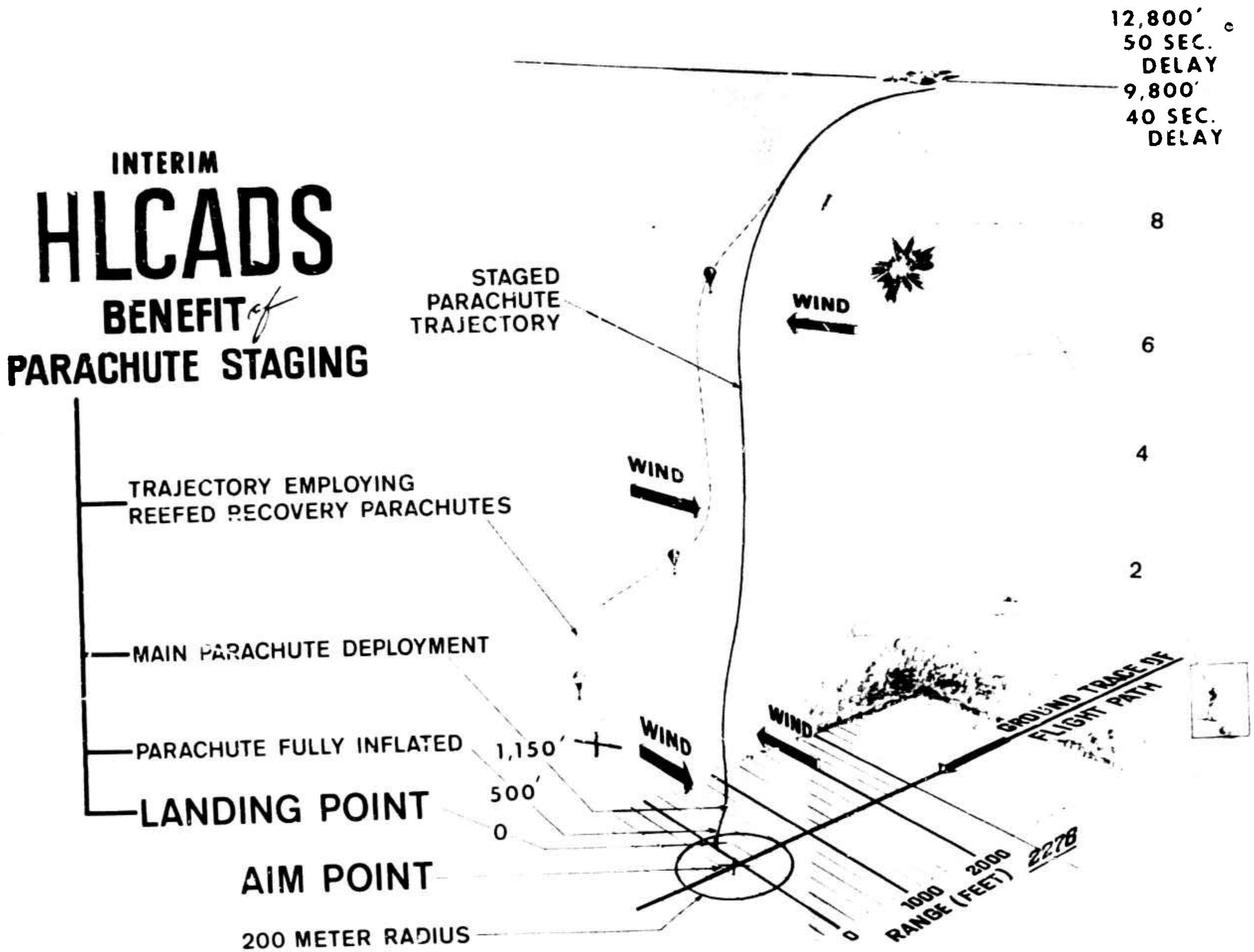
e. One 68-inch pilot parachute.

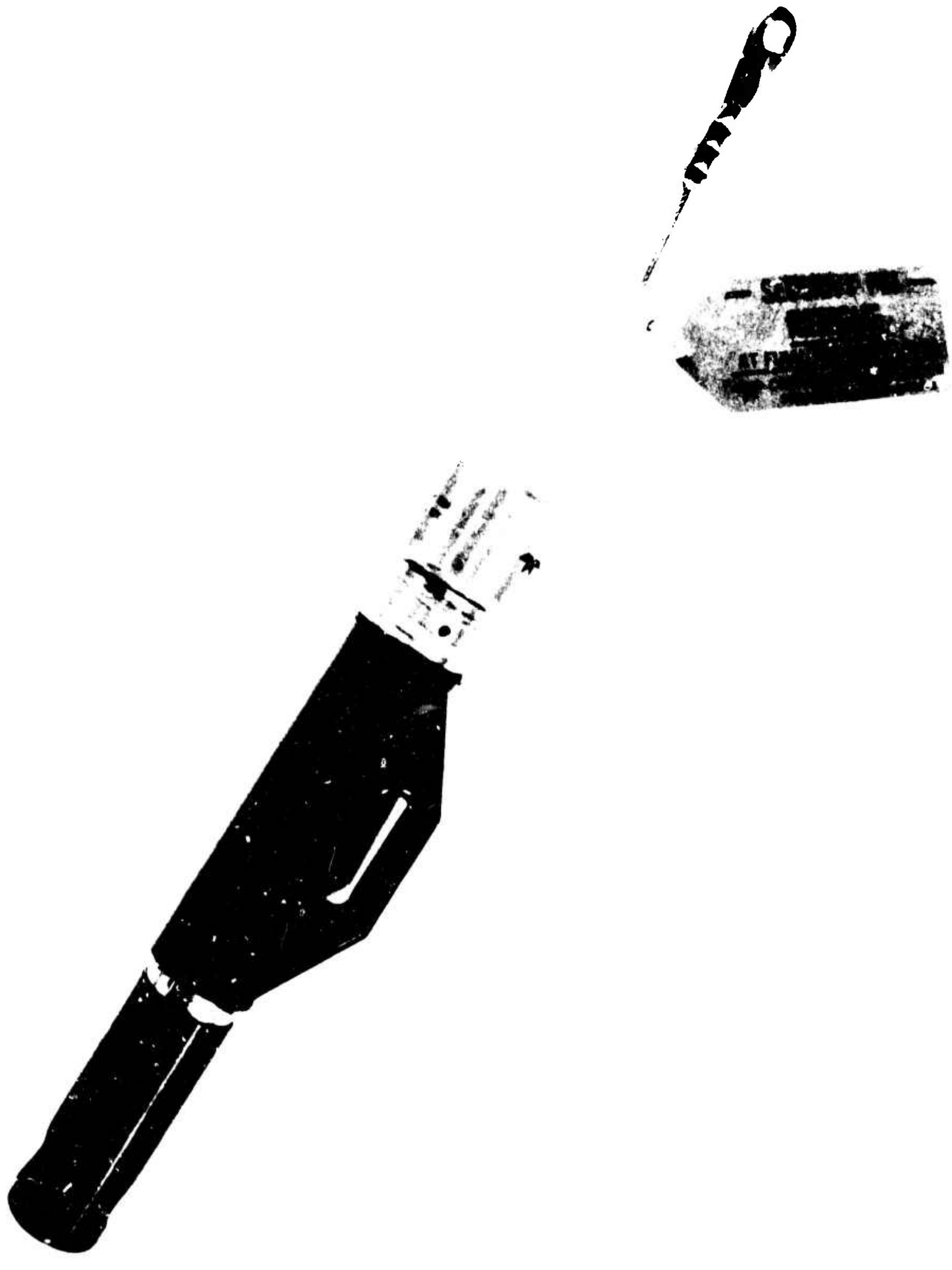
f. One G-12D cargo parachute with 57' Pull Down Vent (PDV) Line.

2-2. Operation of System: The Interim HLCADS Airdrop System provides for the delivery of A-22 containers from a C-7A, a C-119, a C-123, or a C-130 aircraft flying at more than 9,800 foot altitude. The containers can be dropped singly or in multiples up to sixteen depending on aircraft used. This system employs a 68" pilot parachute which stabilizes the container as it descends at terminal velocity of 250 feet per second. At a predetermined height above the ground the cutter fires and cuts a 1-inch tubular nylon tie. The cutting of this tie releases the first-stage 68" pilot chute parachute which is suspended to the outer A-22 container and deploys the second-stage G-12D cargo parachute suspended to the inner A-22 container. This allows the container to land at a normal rate of descent for low-velocity airdrop.



INTERIM
HLCADS
HIGH LEVEL CONTAINER
AIRDROP SYSTEM
AIRCRAFT RESUMES
NORMAL FLIGHT
HORIZONTAL SPREAD AFTER
DISCHARGE APPROX 50 FT
9,800 FEET
FLIGHT PATH
7°
NOSE UP MAINTAINING LEVEL
FLIGHT TO GRAVITY EJECT CARGO
8
APPROX VERTICAL
DESCENT FROM
6000 FT
4
2
1,150
FT
STABILIZATION PARACHUTE
68" DIAMETER
BALLISTIC
STAGE
MAIN PARACHUTE
G12 WITH PULL
DOWN VENT LINE
FULLY DEPLOYED
MAIN PARACHUTE
AT 500FT
SLOWS LOAD
TO 26FT / SECOND
DESCENT RATE
100 FT
3,000
600
FEET
CONFINED BALLISTIC
CUTTER ACTIVATES THE
PARACHUTE DEPLOYMENT
APPROX 500FT FROM GROUND


INTERIM
HLCADS
BENEFIT of
PARACHUTE STAGING
TRAJECTORY EMPLOYING
REEFED RECOVERY PARACHUTES
MAIN PARACHUTE DEPLOYMENT
PARACHUTE FULLY INFLATED
LANDING POINT
AIM POINT
200 METER RADIUS
STAGED
PARACHUTE
TRAJECTORY
1,150′
500′
0
WIND
WIND
WIND
WIND
12,800′
50 SEC.
DELAY
9,800′
40 SEC.
DELAY
8
6
4
2
GROUND TRACE OF
FLIGHT PATH
RANGE (FEET)
0
1000
2000
2278



TEST OBJECTIVES

a. To determine the suitability of the Interim High Level Container Airdrop System (HLCADS) for use from altitudes of 9,800 ft. to 13,500 ft. above ground level.

b. To determine or verify as appropriate the rigging procedures for the system.

c. To determine or verify as appropriate parachute packing procedures for installation of the Pull Down Vent Line in the G-12D.

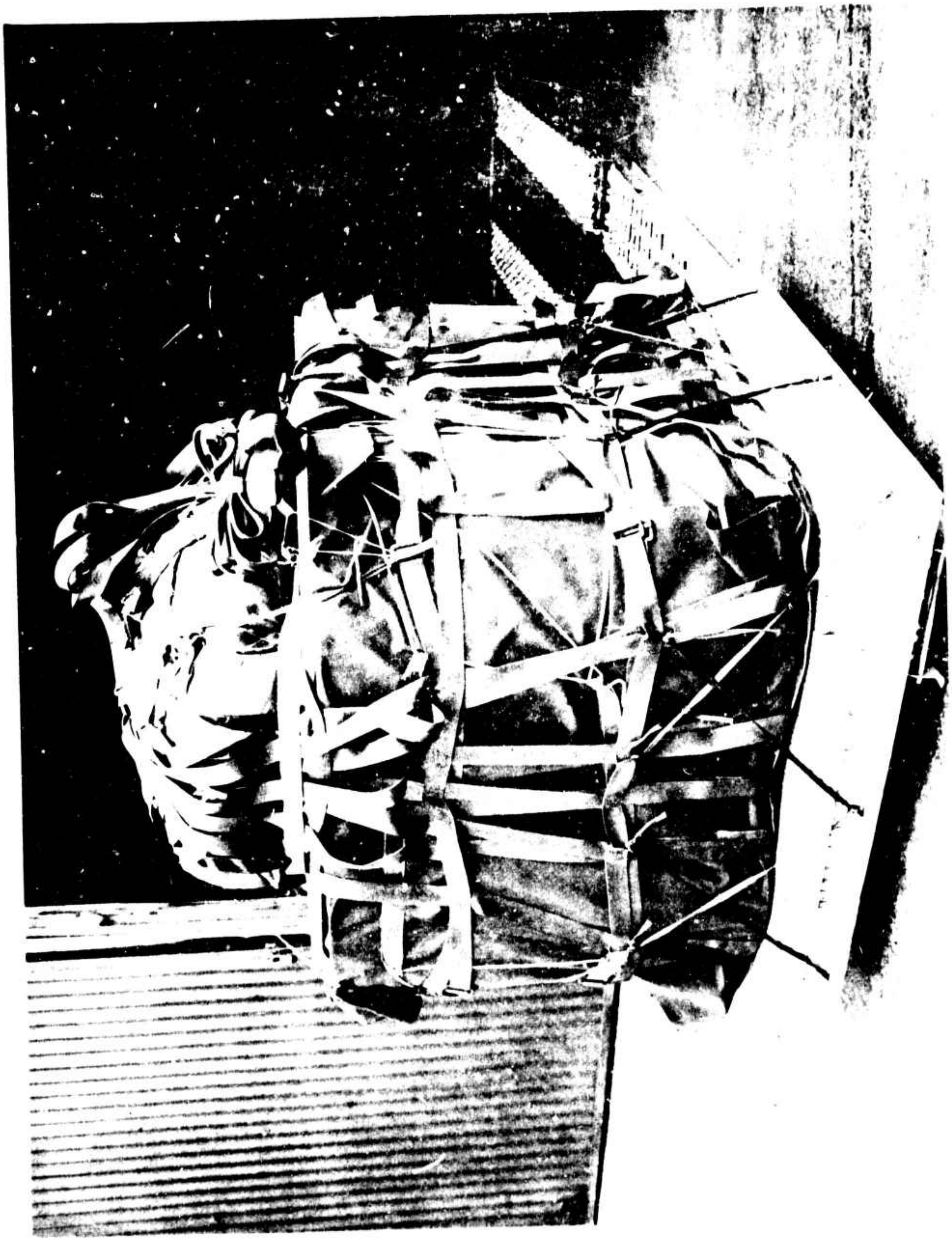
d. To confirm the safety characteristics of The Interim High Level Container Airdrop System.

SCOPE

a. The Military Potential test of the Interim Hi[illegible] Container Airdrop System (HLCADS) was conducted under field conditions [illegible] diate climate of the Fort Bragg and Pope Air Fo[illegible] locale. Airdrop testing began on 24 October 1973 and was completed on 1 November 1973. Testing was conducted by the U. S. Army Airborne, Communications and Electronics Board for US Army Natick Laboratories.

b. The draft rigging procedures supplied by US Army Natick Laboratories were used to rig the 96 loads to determine suitability of the procedures. A TM covering these procedures is being prepared by the Airborne School, Ft. Lee, Virginia. The draft parachute packing instructions for installation of the Pull Down Vent Line were used to pack the 96 G-12D parachutes to determine suitability of the instructions. A TM covering these procedures is being prepared by USAAVSCOM.

c. Criteria for this test were derived from the proposed [illegible] Operational Capability for a High Level Container Airdrop System (Appendix 2).



DETAILS OF TEST

TEST ONE

24 October 1973 AM

40 Sec Time Delay Cutters

7^o Noseup IAS 130 Knots

Drop Altitude 10,200 Ft. AGL 1-5 9,700 Ft. AGL 6-8

Parachute G-12D Pull Down Vent Line without Clevis

Container Number	Time 2nd Stage	Total Time	Distance from IP/Clock Position
1	31	75	350 yds/8
2	36	77	700 yds/11
3	48	89	700 yds/11
4	52	91	350 yds/10
5	45	85	400 yds/7
6	22	65	150 yds/6
7	19	64	350 yds/6
8	14	57	380 yds/7

Results:

1 Good No Burns
2 Good No Burns
3 Good No Burns
4 Cotton Wrapping in Apex Ripped No Burns
5 Good No Burns
6 All lines had burn indications
7 All lines had burn indications
8 Good No Burns

8 Loads Dropped 8 Loads OK

Recommended changes as a result of Test One.

The Pull Down Vent Line can be used without the clevis but a heavier cotton cloth should be used to wrap the apex lines.

Test Conditions.

One load was dropped on each pass.

The first five loads opened between 800 ft. and 1,100 ft. above ground.

On the last three drops the altitude was lowered from 10,200 ft. to 9700 ft. above ground level (AGL).

All pull down vent lines were 9000 lb. capacity.

The loads were located in a single line in the aircraft. The Number 1 bundle was dropped first.

TEST TWO

24 October 1973 PM

40 Sec Time Delay Cutters

7° Noseup IAS 130 Knots

Drop Altitude 9,700 ft. AGL

	Aircraft Station	Container Number		Time on 2nd Stage	Distance from IP/Clock Position
Pass 1	737	9	10	24 Sec	180 yds/6
Pass 2	627	11	12	15 Sec	150 yds/3
Pass 3	560	13	14	36 Sec	75 yds/7
Pass 4	490	15	16	19 Sec	100 yds/6

Results:

9 Good
10 G-12D had holes as result of line over
11 Pilot chutes tangled
12 Pilot chutes tangled
13 Good
14 G-12D had hole as result of line over
15 Pilot chute tangled
16 Pilot chute broke away load lost

8 Loads dropped 7 Loads OK

Recommended changes as a result of Test Two.

Shorten deployment line 5 ft. to reduce entanglement of pilot chutes.

The heavy wrap of apex line solved the burning problem experienced in the first test.

Test Conditions.

Two loads were dropped on each pass. The loads were located side by side.

All Pull Down Vent Lines were 9,000 capacity without a clevis except load No. 13 which used a clevis.

TEST THREE

30 October 1973 AM

40 Sec Time Delay Cutters

7° Noseup IAS 130 Knot

Drop Altitude 9800 Ft. AGL

	Container Number		Time on 2nd Stage	Distance from IP/Clock Position
Pass 1	17	18	28 Sec	500 yds/6
	19	20		
Pass 2	21	22	25 Sec	400 yds/8
	23	24		
Pass 3	25	26	24 Sec	400 yds/8
	27	28		
	29	30		
	31	32		

Results:

17	Slight burn apex old wrap	25	Burns on canopy
18	Slight burn apex old wrap	26	OK clevis
19	No burn old wrap	27	OK clevis
20	Chute ripped	28	OK clevis
21	No burn old wrap	29	OK clevis
22	Good old wrap	30	OK clevis
23	9000 PDV Line broke	31	6000 PDV Line good
24	OK clevis	32	6000 PDV Line broke

16 Loads dropped 16 Loads OK

Recommended changes as a result of Test Three. None

Test Conditions.

3 Passes were made 4 loads were dropped on the first pass. 4 loads on the second pass and 8 loads on the final pass.

TEST FOUR

31 October 1973 AM

40 Sec Time Delay Cutter

7° Noseup IAS 130 Knots

Drop Altitude 9800 Ft. AGL

	Container Number		Distance from Impact Point/Clock Position
Pass 1	33	34	0 yds
	35	36	
Pass 2	37	38	1[illegible] yds/12
	39	40	
	41	42	
	43	44	
	45	46	
	47	48	

Results:

33	9000 PDVL
34	9000 PDVL
35	6000 PDVL
36	Blown canopy
37	Good
38	Good
39	D-Ring on A-22 container broke, load lost
40	Good
41	Canopy damage
42	Good
43	Good
44	Good
45	Good
46	Good
47	Good
48	Blown gore clevis PDVL

1[illegible] loads dropped [illegible]

Recommended changes as result of Test [illegible]

This completed the 9800 Ft. Altitude Drops 48 drops 46 Good

The two failures were caused by:

1. Pilot Chute broke away.

2. Failure of a "D" ring on the A-22 container. (The system worked)

TEST FIVE

31 October 1973 PM

50 Sec Time Delay Cutter

7^{o} Noseup IAS 135 Knots

Drop Altitude 12,800 Ft. AGL

	Container Number		Time 2nd Stage	Total Time	Distance from IP/Clock Position
Pass 1	49	50	21	75	250 yds/6
Pass 2	51	52	20	74	0 yds
Pass 3	53	54	--	--	------
Pass 4	55	56	--	--	------

Results:

49 OK 4000 PDVL broke
50 Pilot Chute broke away
51 Good
52 9000 PDV Line broke
53 High Opener Cutter Fired Early
54 6000 PDV Line OK
55 Pilot Chute broke away
56 6000 PDVL OK No burns

8 Loads dropped 5 Loads OK

Recommended changes as result of Test Five

Load 58 and 57 were rigged with 60" and 120" connector straps, (Type X webbing) with the 60" in the G12 pilot chute bag and 120" outside.

Loads 59 and 60 were rigged with 120" connector strap in the pilot chute bag and 60" outside the bag.

On loads 61 and 62 the deployment line that comes with the pilot chute was used. This is type VIII webbing.

On loads 63 and 64 the deployment line on the pilot chute (Type VIII) was removed and replaced with 120" connector strap. (Type X)

TEST SIX

1 November 1973 AM

10 Sec Time Delay Cutter

7^{o} Noseup IAS 135 Knots

Drop Altitude 12,800

	Container Number		Distance from IP/Clock Position
Pass 1	57	58	1000 yds/7
Pass 2	59	60	400 yds/9
Pass 3	61	62	100 yds/11
Pass 4	63	64	----------

Results:

57 Good no burns
58 Good no burns
59 Good no burns
60 Good no burns
61 Hole in canopy, burns in apex
62 6000 PDV Line good no burns
63 Good no burn
64 Good no burn

8 Loads Dropped 8 Loads OK

Recommended changes as a result of Test Six.

Rig all future loads with Type VIII deployment line and arm the cutter by tieing the lanyard to the container the way load 61 and 62 were rigged This shortens the deployment line down to 9 ft. and should reduce the chance of entanglement of the pilot chutes, and uses the Type VIII deployment line that comes with the G-12 pilot chute.

TEST SEVEN

1 November 1973 PM

50 Sec Time Delay Cutter

7^{o} Noseup IAS 135 Knots

Drop Altitude 12,800 ft.

	Container Number		Distance from IP/Clock Position
Pass 1	65	66	600 yds/6
	67	68	
Pass 2	69	70	150 yds/9
	71	72	
Pass 3	73	74	250 yds/9
	75	76	
	77	78	
	79	80	

Results:

65 Water cans leaked and the water collapsed the pilot chute - load lost
66 Good clevis
67 Good clevis
68 Good clevis
69 Good clevis 4000 lb line broke
70 Good OK
71 Good no burns
72 Cutter did not fire
73 Good no burns
74 Load spin caused the parachute to tear off and deploy high cutter fired at proper time.
75 High opener 4000 lb tubular nylon tie broke
76 Good no burns
77 Good no burns
78 Good
79 Good 9000 no burn
80 Good

16 Loads dropped 12 Loads OK

Recommended changes as result of Test Seven. None.

TEST EIGHT

2 November 1973

50 Sec Time Delay Cutters

7^{o} Noseup IAS 135 Knots

Drop Altitude 12,800 ft.

	Container Number		Distance from IP/Clock Position
Pass 1	81	82	150 yds/1
	83	84	
Pass 2	85	86	110 yds/2
	87	88	
	89	90	
	91	92	
	93	94	
	95	96	

16 Loads dropped 15 Loads OK

Results:

81	Good	89	Good
82	Good	90	Good
83	Good	91	Good
84	Good slight burn	92	Good
85	Good	93	Good
86	Good	94	Good
87	Pilot chute broke away	95	Good
88	Good	96	Good

Change made as result of Test Eight

Replace Type VIII deployment line with 120" connector strap and two connector links.

DISCUSSION OF SYSTEM CONFIGURATION AND PROCEDURES

(1) Parachute System

The 1st stage consists of a 68 inch Diameter pilot chute with 120 inch long connector strap used in place of the Standard Type VIII deployment line.

The 2nd stage consists of the G-12D cargo parachute with a 57 foot long pull down vent line.

(2) Rationale for use of a PDVL

The PDVL permits the parachute to open at a higher critical velocity thus the airdrop load can withstand a higher rate of descent on the first stage. The higher the rate of descent the less time the load is in the air and subject to impact point inaccuracies due to wind variations.

The parachute opening is more consistent. Without the pull down vent line the G-12D will take from 3.5 to 13 seconds to open. With the pull down vent line the G-12D will open between 3.5 to 4.5 seconds.

At a descent velocity of 250 ft/sec and no pull down vent line the parachute would have to initiate opening at 3250 ft. above the ground to assure full opening prior to ground impact. However, if the parachute did open in 3.5 seconds it would be fully opened at 2500 ft. which would result in a very inaccurate airdrop in any kind of a wind condition.

(3) Selection of the Pull Down Vent Line Material

Although a 9000 lb. nylon webbing was first used and found to be satisfactory, the material is not currently available and the large webbing manufacturers are not interested in manufacturing it. However, 6000 lb nylon webbing is available and in production. Several airdrops were performed using this material in the PDVL. Although some of these vent lines did break during opening of the G-12D they broke after performing their function of assuring opening of the G-12D within 3.5 to 4.5 seconds and the broken PDVL's did not produce any parachute damage. Several vent lines of 4000 lb. strength webbing were also tested but these broke on each drop. The 6000 lb. PDVL appears to be a suitable choice of material which will perform its intended function.

(4) Attachment of the Pull Down Vent Line

The original tests were performed using a clevis in the same manner as the G-11 Pull Down Vent System. Although the method was satisfactory, it required a clevis and special wrapping of the clevis.

Because this system is to be deployed to the field immediately, elimination of the clevis was considered desirable and testing was performed without a clevis. Results of the testing indicated the clevis could be eliminated and replaced by a cotton wrap on the PDVL.

Number of wraps was looked into and finally 12" x 18" cotton duck 23.93 oz was considered the best material to wrap the apex to prevent burning of the nylon parachute lines.

(5) Recommended Packing Procedures for the G-12D with 57' Pull Down Vent Line.

The packing procedures were checked out and finalizated and AVSCOM is publishing the following new manual:

DEP AX-SPO-0014

Organizational and DS Maintenance Manual Including Repair Parts and Special Tool List for Interim High Level Container Airdrop System (HLCADS). This manual is expected to be available about mid January 1974.

(6) Rigging Procedures

Rigging Procedures were developed by NLABS for the system and previously tested at the DOD Parachute Test Facility, El Centro, California.

Prior to starting the test at Ft. Bragg, NLABS sent a parachute rigger to Ft. Bragg with a copy of the latest rigging instructions. Loads were rigged in accordance with the instructions. As the test progressed minor changes were made to the instructions.

These changes were made to the draft manual, new pictures were taken and writers from the QM School are presently writing an approved manual.

The major change to the rigging instructions was the shortening of the first stage parachute deployment line from 20 ft. to 10 ft. to reduce the possibility of entanglement of one load with another just after aircraft exit.

(7) Loading the A-22 Container on the Aircraft

When ever possible, the lightest loads should be placed on the aircraft first. Upon ejection from the aircraft the heavy loads have more forward travel distance and open at a lower altitude. This ejection of heavy loads first followed by the lighter loads should reduce collisions between loads

(8) Computer Release Point Data for Dropping Interim HLCADS

CARP Data was developed from the September tests of this system at the DOD Joint Parachute Test Facility El Centro, California.

The drop altitudes for the different time delays were verified.

A 9800 ft. absolute altitude required a 40 second delay.

and a 12,800 ft. absolute altitude required a 50 second delay.

With these altitudes and time delays the opening altitude of the second stage parachute is 500 ft. ± 200 ft.

The total weight of the system should be as close to 2300 lbs as possible, since light loads fall slower they will open higher and drift further because of the higher opening altitude and lower rate of descent. A load heavier than 2300 lbs will fall faster and could conceivably impact the ground before full opening of the parachute.

The CARP data was written in the same manner as Chapter 5 of TACM 55-40 High Altitude Release Point (HARP) solution. This allows the system to be used with AWADS, GRADS and VISUAL.

Although the trojectory data appears to be very good, additional work on programming the AWADS Computer to accept and use the CARP Data is required. See Appendix 3 High Altitude Release Point (HARP) solution for Interim High Level Container Airdrop System (HLCADS).

SUMMARY OF RESULTS

A total of 96 drops were made in this test, 48 at 9800 ft. and 48 at 12,800 ft. Of the 48 dropped at 9800 ft. 46 were good for a 95.8% reliability of the 48 dropped at 12,800 ft. 40 were good for a 83.3% reliability.

A total of 96 drops were made 86 were good for an overall reliability of 90%.

Cause of Failures	Number
1. Deployment line failure	4
2. Cutter failure	2
3. Pilot Chute failure	1
4. 1" tubular nylon broke	1
5. Twisting premature deployment of G-12D	1
6. Container failure	1

Analysis of Failures

a. Deployment lines of two side by side loads become entangled.

The deployment line on the G-12D pilot chute is type VIII nylon webbing rated at 3600 lbs. this was replaced with Type V which is rated 8700 lbs. This will prevent breaking of the line also the deployment line length was reduced from 20 ft. to 10 ft. which will reduce the probability of entanglement.

b. Cutter failures were analyzed by the manufacturer of the cutter and improved QC techniques have been introduced on the production items.

c. Pilot chute failed because the 5 gallon water cans leaked and the water went up into the pilot chute and collapsed it. This was the second drop on this container and it was possible that the lid latch had opened on the first drop and the opening shock on the second caused the cover to open.

d. One tubular nylon tie broke but it was tied to the side of the connector link. The new procedure for rigging the tubular nylon tie will prevent this.

e. Excessive twisting of the loads appears to be caused by loads bumping together or to uneven distribution of weight in the container. If the twisting is severe and the main parachute is not tied down real tight, it may be thrown off the load resulting in premature deployment.

f. The A-22 container failed because the "D"-ring broke. The system worked as programmed but the A-22 container came apart when the G-12D deployed. This is a QC problem for the container and not the system.

CONCLUSIONS

a. The Interim High Level Container Airdrop System (HLCADS) is suitable for use at altitudes up to 13,000 ft.

b. Although the CARP data is suitable for use with the system additional work needs to be done on the computer programming procedures with the AWADS to develop a CARP system suitable for use with AWADS.

c. The rigging procedures provided for the Interim High Level Container Airdrop System (HLCADS) were suitable.

d. The packing instructions provided for installing a Pull Down Vent Line on the G-12D were suitable.

RECOMMENDATIONS

1. The 57' Pull Down Vent Line be fabricated of 6000 lb. breaking strength material.

2. Rigging instructions for the system be published.

3. Packing instructions for the Pull Down Vent Line on the G-12D be published.

4. CARP data for the system be made available to the Air Force and additional work be done on programming this information into the AWADS Computer.

5. Additional testing be performed if airdrop above 13,000 ft. is planned for this system.

6. It is also recommended that instrumented testing be performed to determine the maximum load on the pilot chutes at the higher altitude, maximum load on the Pull Down Vent Line and the opening shock of the G-12D with the Pull Down Vent Line installed.

7. Development continue (DT II) on this Interim High Level Container Airdrop System to result in a system suitable for type classification.

APPENDICES

APPENDIX 1

CONTAINER WEIGHTS

BY NUMBER

1-16	2300
17	2230
18	2280
19	2310
20	2310
23	2370
24	2110
25	2340
26	2300
27	2340
28	2300
29	2290
30	2290
31	2200
32	2210
33	2370
34	2310
35	<u>1890</u>
36	2300
37	2290
38	2340
39	2300
40	2320
41	2310
42	2290
43	2295
44	2300
45	2310
46	<u>2380</u>
47	2310
48	2340
49	2250
50	2310
51	2380
52	2280
53	2320
54	1480
55	2310
56	2280
57	2310
58	2240
59	2310
60	2210
61	2350
62	2300
63	2350
64	2280
65	Unknown thru
80	But between 1890 to 2380
81	2350
82	2330
83	2320
84	2310
85	2275
86	2260
87	2250
88	2240
89	2230
90	2110
91	2180
92	2150
93	2110
94	2110
95	2060
96	1930

TYPES OF LOADS DROPPED

1. 4 - 55 gallon drums filled with water

2. 5 gallon water cans

3. Ammunition boxes filled with sand

APPENDIX 2

PROPOSED REQUIRED OPERATIONAL CAPABILITY FOR A HIGH LEVEL CONTAINER AIRDROP SYSTEM

1. STATEMENT OF NEED.

a. Title: High Level Container Airdrop System. USACDC ACN to be designated by USACDC.

b. Statement of Requirement: There is a requirement for an airdrop system that will permit the delivery of supplies and equipment from aircraft traveling at speeds between 130 and 150 knots indicated air speed (KIAS), and flying at altitudes between 2,000 and 25,000 ft. This system will provide for stabilized fall of loads, weighing up to 2,200 pounds, from release altitude to an altitude at which a device will actuate decelerator deployment, to allow safe and accurate delivery onto unprepared drop zones (DZ) within a 200 meter Circular Error Probable (CEP) from a designated impact point at 10,000 ft, and with a lesser degree of accuracy at 25,000 ft. The term "system" shall include components to accomplish release, stabilization, staging, and deceleration, as well as such other support equipment as may be needed.

c. CDOG Paragraph Number: CDOG para to be designated by USACDC.

d. Priority: Priority I is recommended.

2. TIME FRAME. IOC date FY 77.

3. THREAT/OPERATIONAL DEFICIENCY. The deficiency which exists at the present time is that the current container delivery system is released at 600-750 ft above ground level (AGL) making the drop aircraft vulnerable to hostile small arms and surface to air missile fire. In efforts to avoid this ground fire, the aircraft flies and releases the containers at heights higher than 600 feet AGL. This results in unacceptable drop zone accuracy, which is caused by the increased time that the system is in flight, and the effect the winds and aerodynamic anomalies have on the system as it is falling thru the air.

4. OPERATIONAL/ORGANIZATIONAL CONCEPT.

a. Operational Concept. This system will be used by units which support airdrop of supplies and equipment such as rations ammunition, POL, and medical supplies. It will be used in all climatic conditions where airdrop is performed with minimum change in the system. It is anticipated that the present operational deficiency described above will be overcome by this High Level Container Airdrop System which allows for:

(1) Initial deceleration by stabilized descent from release altitude between 2,000 and 25,000 feet above ground level.

(2) Staging to a recovery mode at the minimum height which will consistently allow full deceleration prior to ground impact.

(3) An accuracy defined by a 200 meter CEP from a designated impact point from an altitude of 10,000 ft, and with a lesser degree of accuracy at 25,000 ft.

b. Organisational Concept. This system will be authorised to units whose mission is the preparation of supplies and equipment for airdrop.

5. ESSENTIAL CHARACTERISTICS.

a. The system must be capable of delivering combat serviceable supplies and equipment under the following conditions:

(1) In containers weighing from 1,500 to 2,200 pounds.

(2) From aircraft flying between 130-150 knots.

(3) In ground winds with velocities from zero to 15 knots.

(4) From heights between 2,000 and 25,000 feet AGL.

b. No additional user ground based equipment (TOE) will be required on the DZ.

c. The system must permit release of multiple loads from a single aircraft making a single pass over the drop zone with the accuracy of the centroid of the impact points of the loads defined by a CEP of 200 meters.

d. The system shall achieve a mission reliability of 95 percent.

e. The system must be compatible with existing equipment to the greatest practical extent.

f. The components of the system must not present any hazards to personnel during installation and use.

g. The system will be capable of employment in the climatic conditions described in Section 2, AR 70-38.

h. For storage and transit conditions, the system will meet the criteria in AR 70-38.

i. The system must be capable of withstanding normal handling incident to field use.

j. Organizational maintenance will be limited to inspection, disassembly, replacement of damaged or expended components, and assembly.

k. No skills other than those of the Parachute Rigger, MOS 43E, will be required to maintain this system at the organizational level.

6. TECHNICAL ASSESSMENT. A system feasibility study indicates that, under nominal conditions, the requirements stated above can be met, when dropping from 10,000 feet or less, by a two-stage parachute system consisting of a small stabilizer for the ballistic mode and a larger parachute for the recovery mode, provided:

a. The ballistic-stage terminal velocity is 250 ft/sec, or more.

b. The CARP calculation is based on current values of wind at drop altitude and wind on the DZ.

c. Staging occurs at a known height above the ground, regardless of load anomalies or atmospheric variations. Nominal conditions are defined by:

GRW = 2200 lb.	DZ wind - 15 kt.
Release vel. = 130 kt.	ICAO Standard Day.

Departure from nominal conditions will probably increase the CEP to more than 200 m, but not excessively, if conditions, a, b, c are met. Dropping from as high as 25,000 feet may be expected to increase the CEP by an amount to be determined during the advanced development phase. Condition a. can be met, under nominal conditions, by a stabilization/deceleration system based on the G-12D parachute, modified for vent control. NLABS tests have confirmed this.

d. Condition b. can be met by the Air Force AWAD System operating in conjunction with wind measurements on the drop zone.

e. Condition c. can be met by the Air Force PARS device, or by a device under development by Harry Diamond Laboratories (HDL).

f. The HLCAD System, under development by NLABS, will combine these elements into a fully-integrated airdrop system.

7. COST ASSESSMENT.

a. 161 thousand dollars have been expended, thus far, in the development of the HLCAD System. It is estimated that the system can be brought to type classification for an additional Army expenditure of 1.21 million dollars, for a total estimated RDT&E cost of 1.37 million dollars. No non-recurring investment will be needed.

b. The system in the field is expected to require a recurring investment between 1250 and 2250 dollars per unit. Included in this cost are a radar ground sensor, a staging actuator, a ballistic stabilization parachute, and a recovery parachute capable of opening at the requisite speed. Except for thermal batteries (to be used in combat only) these items are to be completely reusable.

c. This project is expected to remain in the advanced development stage, category 6.3, through FY 74. In FY 74, 510 thousand dollars of 6.3 funds will be needed.

APPENDIX 3

HIGH ALTITUDE RELEASE POINT (HARP) SOLUTION

FOR

INTERIM HIGH LEVEL CONTAINER AIRDROP SYSTEM (HLCADS)

1. High Altitude Release Point (HARP) Solution.

MC Form -36, "High Altitude Release Point Computations," will be used to solve and record HARP Data.

a. General. The HARP solution is a basic CARP solution with an additional freefall or first stage factor prior to the normal CARP solution. HALO drops using these procedures are primarily concerned with A-22 container drops being made by use of a timer, Radar Sensor or a Barometric activated 2nd stage parachute release. A HARP will be computed for all HALO releases. During drops involving multiple passes a HARP will be computed when changing drop altitude or when a significant wind change has occurred.

b. Parachutes. Parachutes for Interim High Level Container Airdrops Systems (HLCADS) consists of 68" G-12 pilot chute for the first stage and G-12D with 57' Pull Down Vent for the second stage.

c. Basic Assumptions. The deployment altitude of 500 ft. is considered to be the altitude where full second stage parachute deployment occurs and a constant rate of descent is established.

d. Navigator. The navigator will review the wind, altitudes, free fall times, point of impact locations, terrain, and obstacles for the intended drop. The HARP location will be thoroughly reviewed and red light position and/or times will be established.

e. Altitudes:

(1) Pressure altitude or indicated true altitude is used as the aircraft drop altitude reference. The drop altitude and deployment altitude must be converted to true/indicated altitude for HARP computations.

(2) The fixed altitude and time delay determine the deployment altitude.

f. Winds. There are two winds used in HARP computation:

(1) Free Fall Wind or First Stage. The vectorial average of the winds from drop altitude to deployment altitude.

(2) Deployed Wind. The vectorial average of the winds from deployment altitude to the surface.

(3) The weather forecaster is not trained in giving the vectorial average of winds other than a personal estimate. The navigator should request winds at the required altitudes and compute the vectorial average on his computer. The altitude for computing the free fall wind is 100, 75, 50, and 25 percent of the free fall distance above deployed altitude. In event the altitude between the above mentioned percentages exceeds 5,000 feet use winds at every 1,000 feet altitude for computing the vectorial average.

g. Signals:

(1) The normal green light time will be as the HARP solution indicates.

(2) The "red light" position and/or timing will be determined by the navigator.

2. HARP Solution Computations. The basic steps for HARP computations, MC Form 856, are: (Sample problem shown in paragraph 5-3.)

a. Item 1. Drop Altitude Information - the forecast or inflight wind is used to obtain drop zone heading, ground speed, and indicated true altitude.

(1) Indicated Airspeed (IAS) - 130 Knots. (For Interim HLCADS)

(2) The True Airspeed (TAS) is determined by using the computer AIR-SPEED COMPUTATION scale:

$$\frac{\text{Temperature at Altitude}}{\text{Pressure Altitude}} = \frac{\boxed{\text{TAS}}\ \text{(True Air Speed)}}{\text{EAS (Equivalent Air Speed)}}$$

Equivalent Air Speed (EAS) = IAS ≠ instrument corrections. In the sample problem EAS = IAS.

Correct IAS for all factors that effect TAS computations.

(3) Terrain Elevation - in true elevation. (Highest Elevation on Drop Zone)

(4) Indicated Altitude - The pressure level which the pilot will fly to obtain the correct drop altitude (absolute altitude) over the drop zone with the latest altimeter setting in the Kollsman window of the pressure altimeter. The indicated true altitude is computed:

(a) For HALO airdrops at 4,000 feet (AA) or below use the computer ALTITUDE COMPUTATION scale, Formula B:

$$\frac{\text{Drop Altitude Temperature}}{\text{True Altitude}} = \frac{\boxed{\text{Drop Altitude}}}{\text{Corrected Drop Altitude}}$$

Pressure altitude is determined:

1. Adding drop altitude and terrain elevation to obtain true altitude.

2. Correct true altitude for pressure altitude variations (PAV) computed using the DZ, altimeter setting. When the altimeter setting is greater than 29.92, the PAV is subtracted from true altitude to obtain pressure altitude.

(b) For HALO airdrops above 4,000 feet (AA) compute:

1. Determine the true altitude by adding the terrain elevation to the required drop altitude. The terrain elevation will be the highest point on the DZ.

2. Algebraically subtract the "PAV" from the true altitude to find the correct pressure altitude.

b. Item 2. Drop altitude - the absolute altitude above the highest point on the drop zone. This altitude will be determined by joint training manuals or mission directives

c. Item 3. Altitude Lost to Terminal Velocity - altitude the equipment will descent from exit until reaching terminal vertical velocity. Altitude lost for interim HLCADS can be obtained from attachment 5.

d. Item 4. Altitude at Terminal Velocity - subtract Item 3 from Item 2.

e. Item 5. Deployed Altitude - the highest altitude where the parachute will be fully deployed and has attained a constant rate of descent. For this system the deployed altitude is 500 ft.

f. Item 6. Free Fall Distance - Item 4 minus Item 5.

g. Item 7. Total Time of Fall at Terminal Velocity - the total time of free fall, in seconds, the container would take to fall from the point where terminal vertical was obtained until falling to the surface (attachment 5).

h. Item 8. TF Deployment Altitude to Ground - the time of fall, from the deployment altitude to the ground at terminal velocity for the interim HLCADS system this is 2 seconds (500 ft altitude at 250 ft/sec terminal velocity).

i. Item 9. Total Time at Terminal Velocity - subtract Item 8 from Item 7.

j. Item 10. Average Free Fall Altitude - average altitude used to compute the average rate of free fall. This point is computed by adding 2/3 of the free fall distance to the deployment altitude.

k. Item 11. Free Fall Temperature - the temperature (^{o}C) for Item 10. The temperature at two-thirds of the free fall distance above the deployment altitude. (Obtain from the weather man).

l. Item 12. Adjusted Total Time at Terminal Velocity - in seconds, determined by using the computed AIRSPEED COMPUTATION scale:

$$\frac{\text{Free Fall Temperature}}{\text{Average Free Fall Altitude}} = \frac{\text{Total Time at Terminal Velocity}}{\boxed{\text{Adjusted Total Time at Terminal Velocity}}}$$

m. Item 13. Time to Terminal Vertical Velocity - the time, in seconds, green light until the container has obtained zero forward true airspeed and has reached its terminal vertical velocity. This time can be obtained from attachment 5. Enter the chart with drop altitude at time of exit. The heavy solid line denotes the average free fall time.

n. Item 14. Total Time of Free Fall or Time on First Stage - the sum of Item 12 and Item 13, the total time of free fall from green light to deployment altitude.

o. Item 15. Free Fall Wind - the free fall mean vectorial wind from drop altitude to deployment altitude.

p. Item 16. Free Fall Drift Effect - the wind effect in yards, from exit to deployment altitude determined by the formula:

$$\frac{\text{Wind Speed}}{1.78} = \frac{\boxed{\text{Free Fall Drift Effect in Yards}}}{\text{Total Time in Seconds}}$$

This wind effect will be plotted upwind from the deployed drift effect vector. Item 23 must be plotted before plotting this vector (reference figure 5-2).

q. Item 17. Initial Vector - the ground distance from green light to terminal vertical velocity. It is plotted in yards in the direction of motion (true heading at moment of release). The initial vector is computed by the formula:

$$\frac{\text{Ground Speed}}{1.78} = \frac{\boxed{\text{Distance Traveled in Yards}}}{\text{Time to Terminal Vertical Velocity in seconds}}$$

This vector will be plotted from the free fall drift effect vector toward the initial point. Item 16 and Item 23 must be plotted first.

r. Item 18. Deployment Altitude Temperature - in degrees centigrade.

s. Item 19. Rate of Fall - The standard day rate of fall is 26 ft/per second for G-12D with Pull Down Vent Line.

t. Item 20. Adjusted Rate of Fall - rate of fall corrected for air density determined by using the AIRSPEED COMPUTATION scale:

$$\frac{\text{Temperature}}{\text{Pressure Altitude}} = \frac{\boxed{\text{Adjusted Rate of Fall}}}{\text{Rate of Fall}}$$

u. Item 21. Deployed Time of Fall - determined by the computer formula:

$$\frac{\text{Adjusted Rate of Fall}}{\text{Deployment Altitude}} = \frac{10}{\boxed{\text{Time of Fall in Seconds}}}$$

This wind effect will be plotted upwind from the point of impact.

v. Item 22. Deployed Wind - the mean vectorial wind from deployment altitude to the surface.

w. Item 23. Deployed Drift Effect - the wind effect, in yards, from deployment altitude to the surface determined by the formula:

$$\frac{\text{Wind Speed}}{1.78} = \frac{\boxed{\text{Deployed Drift Effect in Yards}}}{\text{Time of Fall in Seconds}}$$

This wind effect will be plotted upwind from the point of impact.

x. Item 24. Stop Watch Distance - the distance in yards from the HARP to the timing point.

y. Item 25. Stop Watch Time - stop watch distance is converted to time (nearest 1/10 second) by the computer formula:

$$\frac{\text{Ground Speed}}{1.78} = \frac{\text{Stop Watch Distance in Yards}}{\boxed{\text{Stop Watch Time in Seconds}}}$$

z. Item 26. DZ Length - the distance in yards, from the point of impact to the end of the DZ. Only the coordinates of the point of impact may be given in some mission directives.

aa. Item 27. Stop Drop Time - add useable DZ time to the stop watch time.

bb. Item 28. Parachute Activation Altitude - the absolute altitude above the DZ at which the second stage sensor starts parachute activation.

cc. Item 29. Vertical Distance - the vertical distance required for full deployment of the parachute after parachute activation was initiated. Vertical distance is 400 ft.

dd. Item 30. Deployment Altitude - 500 ft.

5-3. <u>Sample HARP Problem (Figure 5-3)</u>:

a. Given:

(1) Drop Altitude — 9,800 Ft.
(2) Deployed Altitude — 500 Ft.
(3) DZ Elevation — 490 Ft.
(4) Winds:
   (a) 10,000 ft. — 270°/60 kts
   (b) 8,000 ft — 305°/50 kts
   (c) 6,000 ft — 320°/40 kts
   (d) 4,000 ft — 345°/30 kts
   (e) 2,000 ft — 350°/20 kts
   (f) 1,000 ft — 360°/15 kts
   (g) Surface — 010°/10 kts
(5) Temperature:
   (a) Drop Altitude — -4°C
   (b) 5,000 — +1°C
   (c) Surface — +12°C
(6) Drop Zone:
   (a) True Course — 238°
   (b) Variation — +3-1/2
   (c) IAS — 130 kts
   (d) PAV — -100 ft
(7) Altimeter Setting at DZ — 30.02
(8) Equipment Airdrop Example, activate parachute release at 900 feet absolute altitude.
(9) + 3 correction IAS to EAS.
(10) Two Stage Parachute System

b. Determine:

(1) Drop Altitude
   (a) True airspeed
   (b) True heading
   (c) Magnetic heading
   (d) Ground speed
   (e) Indicated altitude
(2) HARP
(3) Winds
   (a) Free Fall
   (b) Deployed
(4) Stop watch time
(5) Indicated altitude for drop

c. Solution:

(1) Item 1. Drop Altitude Information.
   (a) Determine Pressure altitude
      <u>1</u>.

Drop Altitude	9,800 feet
Terrain Elevation	480 feet
True Altitude	10,280 feet
PAV (Reference <u>(2)</u> below	-100 feet
Pressure Altitude	10,180 feet

2. Forecast DZ Alt Setting — 30.02 inches
Standard Altimeter Setting — 29.92 inches
Difference — .10 inches (Equiv to 100 ft. alt.)

(b) Determine TAS (151 KIAS) apply drop altitude wind (270^{o}/60K) to obtain MH (253 $1/2^{o}$) and GS (239K).

(c) Determine indicated altitude:

$$\frac{\text{Drop Altitude Temperature}}{\text{Indicated Terrain Elevation}} = \frac{\text{Drop Altitude}}{\text{Corrected Drop Altitude}}$$

Corrected Drop Altitude	9,750 feet
Terrain Elevation	490 feet
Indicated Altitude	10,240 feet

(2) Item 2. 9,800 feet given.
(3) Item 3. 2,265 feet, use Table 1, enter with 9,800 feet altitude.
(4) Item 4. 7,535 feet, Item 2 minus Item 3.
(5) Item 5. 500 feet.

(a) Equipment drops with timer activated cutter. Complete Items 28 through 30 prior to entering Item 5.

(6) Item 6. 7,035 feet. Item 4 minus Item 5.
(7) Item 7. 36 seconds. Table 3 enter with 7,535 feet.
(8) Item 8. 2 seconds. Table 3 enter with 500 feet.
(9) Item 9. 34 seconds. Item 7 minus Item 8.
(10) Item 10. 5,195 feet. Take 2/3 of Item 6, plus Deployment Altitude.

(7,535 feet) -	Free Fall Distance	4695
	Plus deployed alt	500
Average Free Fall Altitude		5195 feet

(11) Item 11. +1 Temperature for 5,195 feet.

(12) Item 12. 30.0 seconds. Computer Formula D.

$$\frac{\text{+1 Temperature}}{\text{5,195 ft. Pressure Altitude}} = \frac{\text{34.0 Secs Total Time at Terminal Velocity}}{\text{30.0 Secs Adj Total Time at Terminal Velocity}}$$

(13) Item 13. 11.6 seconds. Table 2, enter with 9800 feet drop pressure altitude.
(14) Item 14. 42.9 seconds. The sum of Items 12 and 13.
(15) Item 15. 325^{o}/35Kts.

(16) Item 16. Determine free fall drift effect by computer Formula E.

$$\frac{\text{35K Free Fall Wind Speed}}{1.78} = \frac{\text{Free Fall Drift Effect - 843 yds}}{\text{42.9 Secs Total Free Fall Time}}$$

(17) Item 17. Determine Initial Vector by computer Formula E.

$$\frac{\text{98 Kts Ground Speed}}{1.78} = \frac{\text{981 Yards Initial Vector}}{\text{11.6 Secs - Time of Terminal Vertical Velocity}}$$

(18) Item 18. +11 Given.

(19) Item 19. 260 ft/sec.

(20) Item 20. Determine adjusted rate of fall, Formula G by using AIRSPEED COMPUTATION scale.

$$\frac{\text{+11 Deployed Altitude Temperature}}{\text{990 Pressure Altitude}} = \frac{\text{26.0 Ft/Sec Adjusted Rate of Fall}}{\text{26.0 Ft/Sec Rate of Fall}}$$

(21) Item 21. Determine Deployed Time of Fall by computer Formula H.

$$\frac{\text{26.0 Ft/Sec Adjusted Rate of Fall}}{\text{500 ft Deployment Altitude}} = \frac{1.0}{\text{19.2 Sec Deployed Time of Fall}}$$

(22) Item 22. Deployed Wind 005/12

(23) Item 23. Deployed Drift Effect determined by computer Formula I.

$$\frac{\text{12 Kts Deployed Wind Speed}}{1.78} = \frac{\text{130 Yds Deployed Drift Effect}}{\text{19.2 Sec Time of Fall}}$$

(24) Item 24. 1,000 yards measured from the HARP to a timing point.

(25) Item 25. 18.2 seconds. Stop Watch time determined by computer Formula I.

$$\frac{\text{98 Kts Ground Speed}}{1.78} = \frac{\text{1,000 Yds Stop Watch Distance}}{\text{18.2 Sec Stop Watch Time}}$$

(26) Item 26. 4,000 yards. DZ length measure from point of impact to the end of the DZ. DZ time determined by using computer Formula J.

(a) $\frac{\text{98K Ground Speed}}{1.78} = \frac{\text{4,000 Yards Useable DZ Length}}{\text{73 Sec Stop Watch Time}}$

(b)

Stop Watch Time	73.0 Seconds
Reaction Time	1.0 Seconds
Useable DZ Time	72.0 Seconds

(27) Item 27. 36.3 Seconds. The sum of Items 25 and 26.

(28) Item 28. 900 feet. Briefed absolute altitude above point of impact where initial parachute deployment will start.

(29) Item 29. 400 feet.

(30) Item 30. 500 feet. Item 28 minus Item 29.

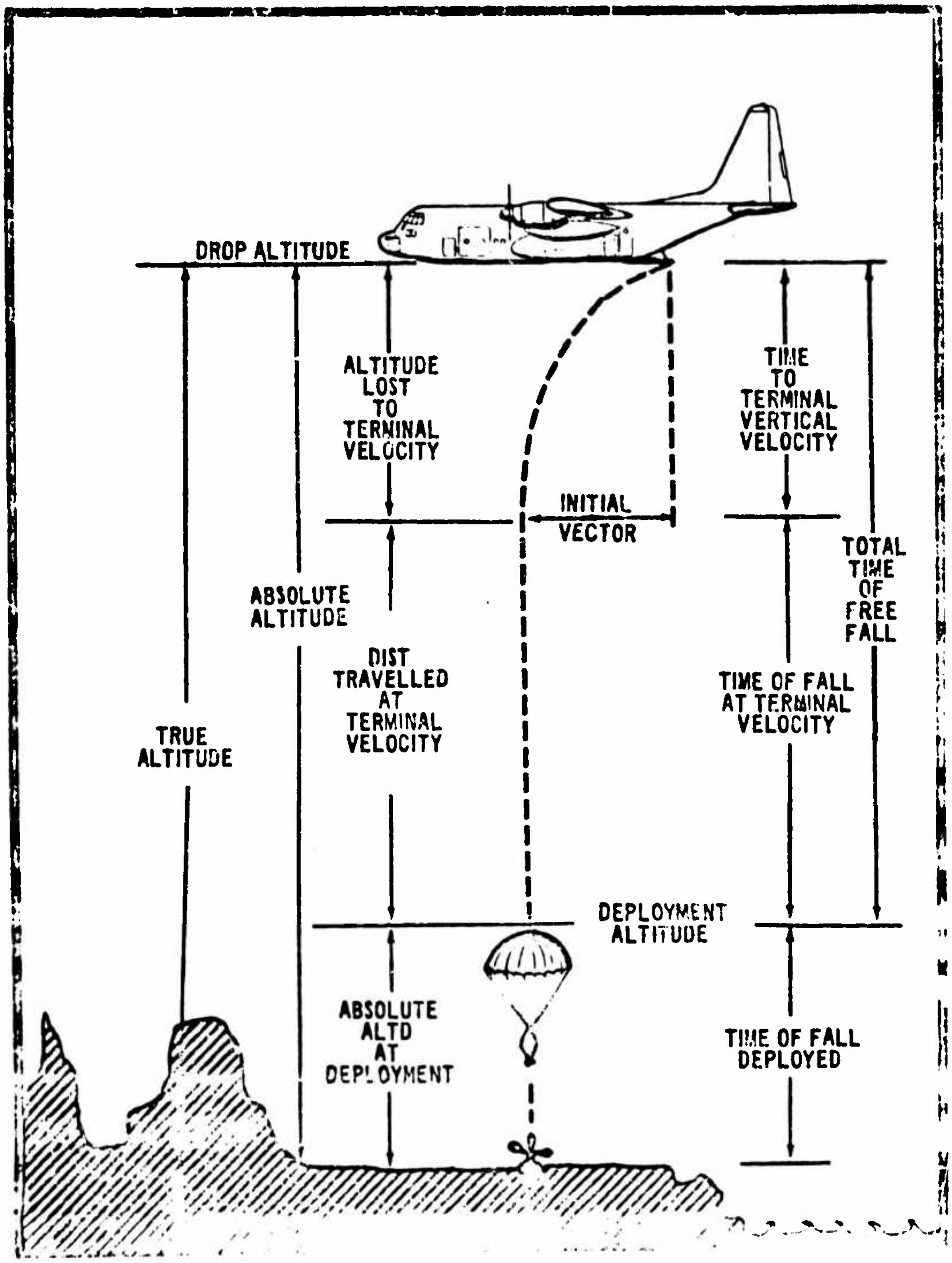


Figure 5-1. HARP Vertical Diagram

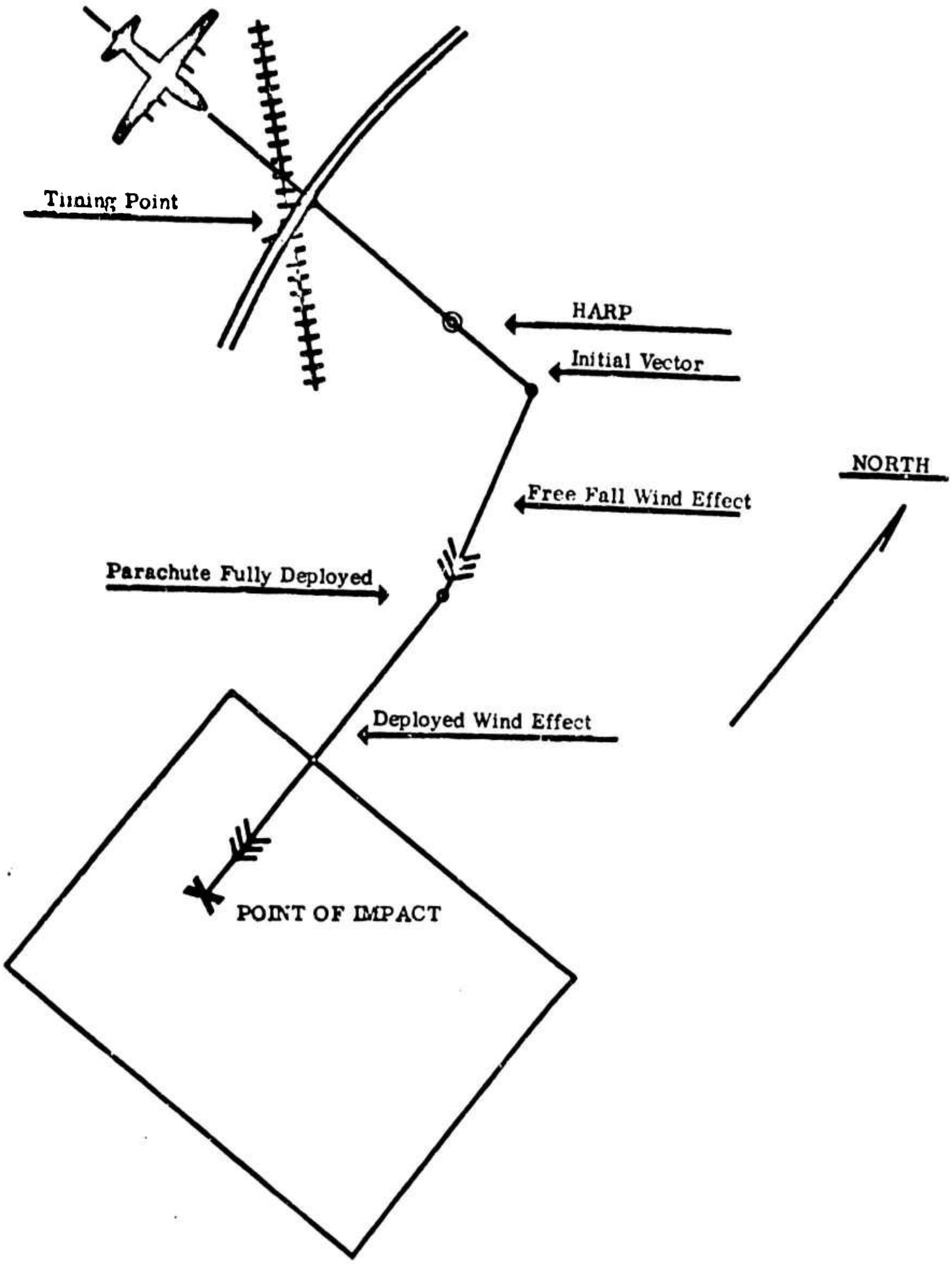


Figure 5-2. HARP and DZ Diagram

Enlarge 20% to fit on 8 x 10-1/2 paper.

HIGH ALTITUDE RELEASE POINT COMPUTATIONS

DATE	
NAVIGATOR *(Name and Grade)*	SIGNATURE OF NAVIGATOR
ORGANIZATION / DROP ZONE	AIRCRAFT IDENTIFICATION
PILOT *(Name and Grade)*	DZ ALT SETTING: 30.02
	ETA/ATA

1. DROP ALTITUDE INFORMATION

TEMP / ALT	IAS / TAS	TC	W	V	DC	TH	VAR	MH	GS
-4 / 9,800	130 / 151	238	273	60	412	250	+3½	253½	98

DROP ALTITUDE (AA)		9,800
TERRAIN ELEVATION	+	490
TRUE ALTITUDE		10,290
PRESSURE ALTITUDE VARIATION	± A	-100
PRESSURE ALTITUDE		10,190
CORRECTED DROP ALTITUDE	B	9,750
TERRAIN ELEVATION	+	490
INDICATED ALTITUDE		10,240

2. DROP ALTITUDE		9,800	
3. ALTITUDE LOST TO TERMINAL VELOCITY	C	2,265	
4. ALTITUDE AT TERMINAL VELOCITY		7,535	
5. DEPLOYED ALTITUDE		500	
6. FREE FALL DISTANCE		7 035	
7. TOTAL TF AT TERMINAL VELOCITY	C	36.0	
8. TF DEPLOYED ALTITUDE TO GROUND	-	2.0	
9. TOTAL TIME AT TERMINAL VELOCITY		34.0	
10. AVERAGE FREE FALL ALTITUDE		5,[illegible]	
11. FREE FALL TEMPERATURE		+1	
12. ADJ TOTAL TIME AT TERMINAL VELOCITY	D	30.[illegible]	
13. TIME TO TERMINAL VERTICAL VELOCITY	+ C	11.6	
14. TOTAL TIME OF FREE FALL		42.9	
15. FREE FALL WIND		325/35	
16. FREE FALL DRIFT EFFECT	E	84[illegible]	
17. INITIAL VECTOR	F	981	
18. DEPLOYED ALTITUDE TEMPERATURE		+11	
19. RATE OF FALL		26.0	
20. ADJUSTED RATE OF FALL	G	26.0	
21. DEPLOYED TIME OF FALL	H	19.2	
22. DEPLOYED WIND		005/12	
23. DEPLOYED DRIFT EFFECT	I	130	
24. STOP WATCH DISTANCE		1000	
25. STOP WATCH TIME	J	18.2	
26. USEABLE DZ LENGTH TIME	+ J	4000/72	
27. STOP DROP TIME "RED LIGHT"		91.2	

A. $\frac{29.92}{+}$ $\frac{30.02 - 29.92}{-\ 100}$

B. $\frac{\text{DROP ALTITUDE TEMPERATURE}}{\text{TRUE ALTITUDE}}$: $\frac{\text{DROP ALTITUDE}}{\boxed{\text{CORRECTED DROP ALT}}}$

C. ATTACHMENT 5, HARP COMPUTATION TABLES

D. $\frac{\text{FREE FALL TEMP}}{\text{AVE FREE FALL ALT}}$: $\frac{\text{TOTAL TIME AT TERMINAL VELOCITY}}{\boxed{\text{ADJ TOTAL TIME AT TERMINAL VELOCITY}}}$

E. $\frac{\text{FREE FALL WIND SPEED}}{1.78}$: $\frac{\boxed{\text{FREE FALL DRIFT EFFECT - YARDS}}}{\text{TOTAL TIME OF FREE FALL}}$

F. $\frac{\text{GROUND SPEED}}{1.78}$: $\frac{\boxed{\text{INITIAL VECTOR - YARDS}}}{\text{TIME TO TERMINAL VERTICAL VELOCITY-SECONDS}}$ 11.6

G. $\frac{\text{DEPLOYMENT ALTITUDE TEMPERATURE}}{\text{DEPLOYMENT PRESSURE ALTITUDE}}$: $\frac{\boxed{\text{ADJUSTED RATE OF FALL}}}{\text{RATE OF FALL}}$

H. $\frac{\text{ADJUSTED RATE OF FALL}}{\text{DEPLOYMENT ALTITUDE}}$: $\frac{1.0}{\boxed{\text{DEPLOYED TIME OF FALL - SECONDS}}}$

I. $\frac{\text{DEPLOYED WIND SPEED}}{1.78}$: $\frac{\boxed{\text{DEPLOYED DRIFT EFFECT - YARDS}}}{\text{DEPLOYED TIME OF FALL - SECONDS}}$

J. $\frac{\text{GROUND SPEED}}{1.78}$: $\frac{\text{STOP WATCH DISTANCE - YARDS}}{\boxed{\text{STOP WATCH TIME - SECONDS}}}$

EQUIPMENT COMPUTATIONS

28. PARACHUTE ACTIVATION ALTITUDE (AA)	900
29. VERTICAL DISTANCE	400
30. DEPLOYED ALTITUDE	500

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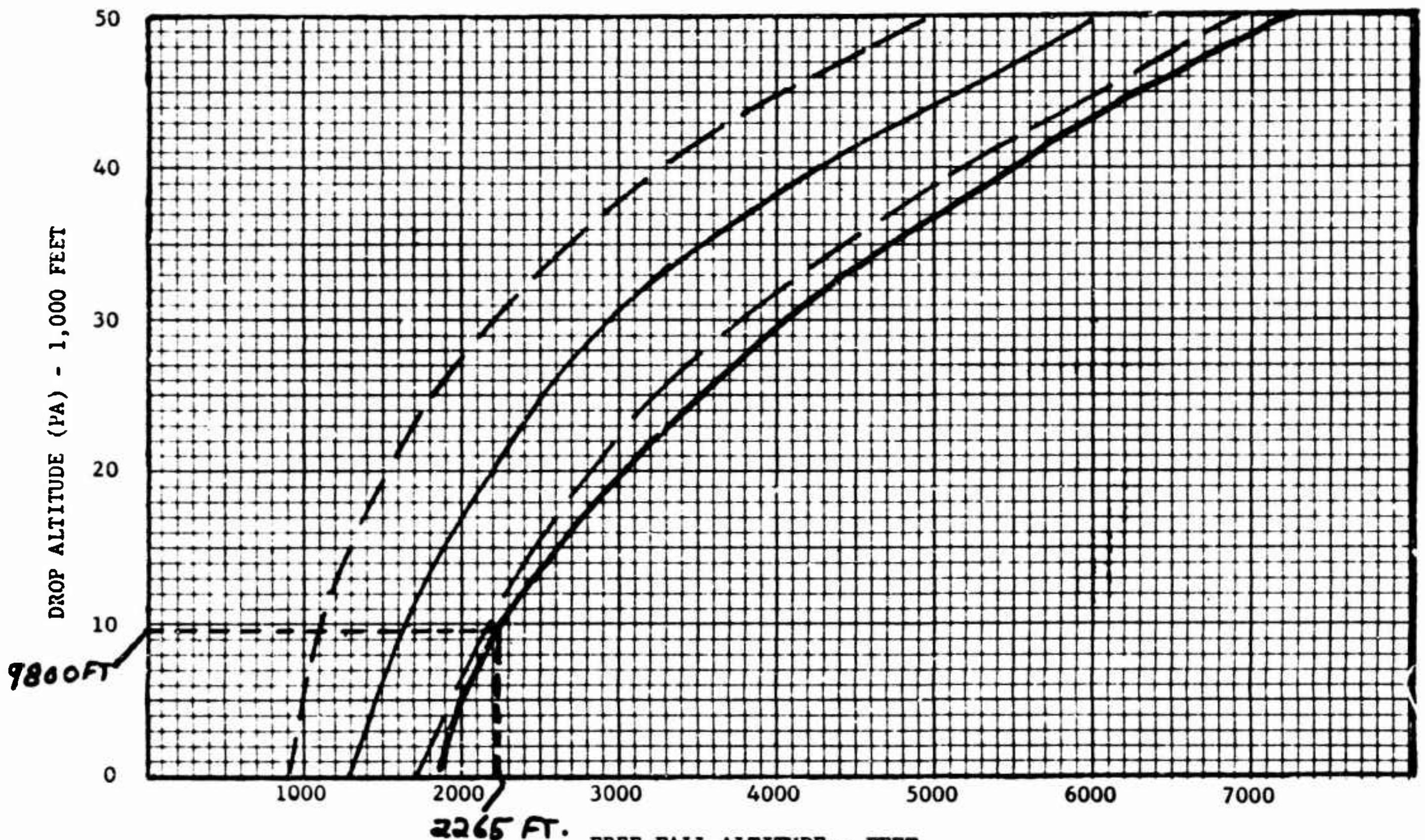
TABLE I

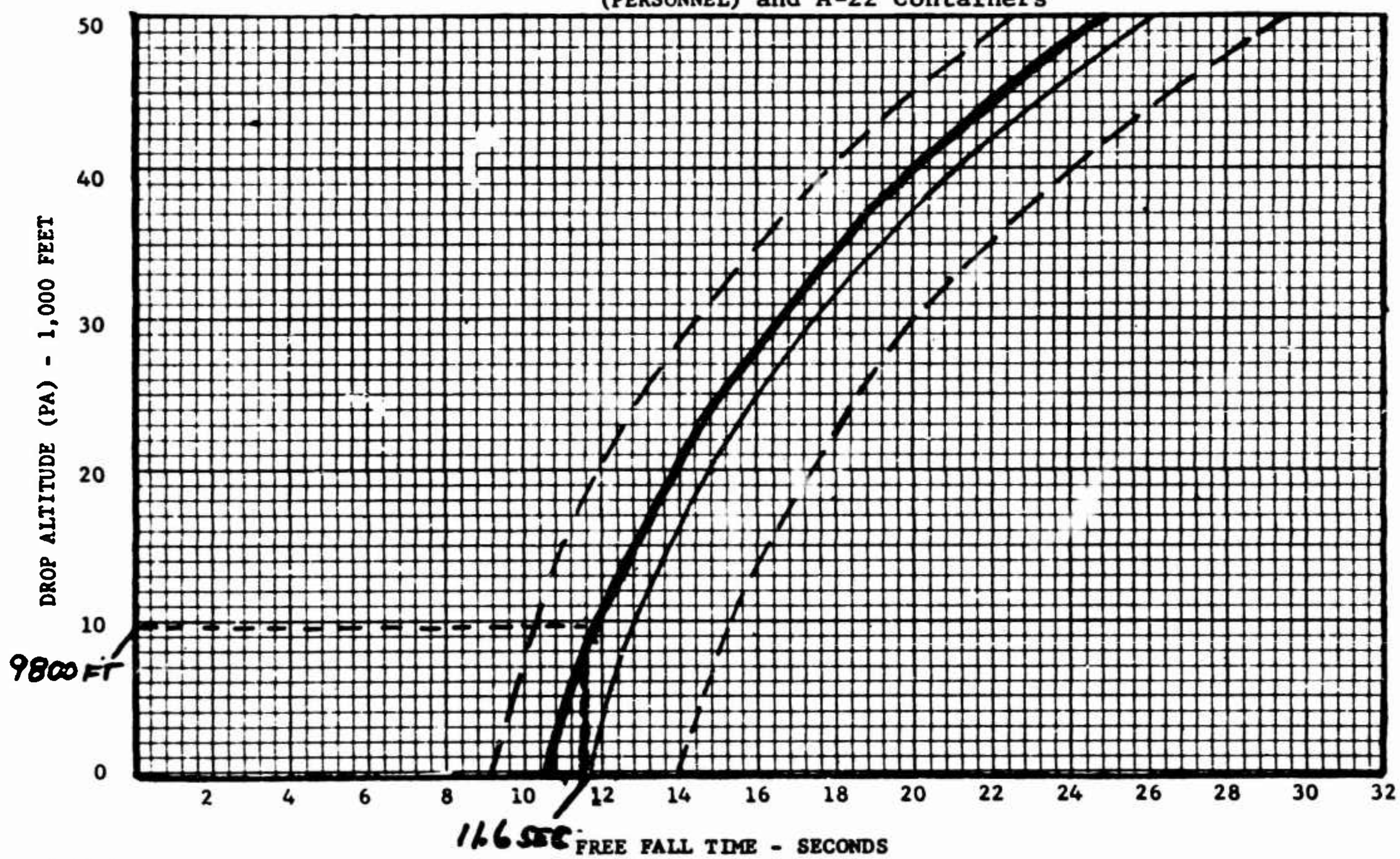
ALTITUDE LOST TO TERMINAL VELOCITY
(PERSONNEL AND A-22 CONTAINERS)



NOTES:
1. Dotted line indicates maximum and minimum
2. Solid line is average data
3. Standard day temperature data
4. Heavy Dark Line Interim HLCADS

TABLE 2

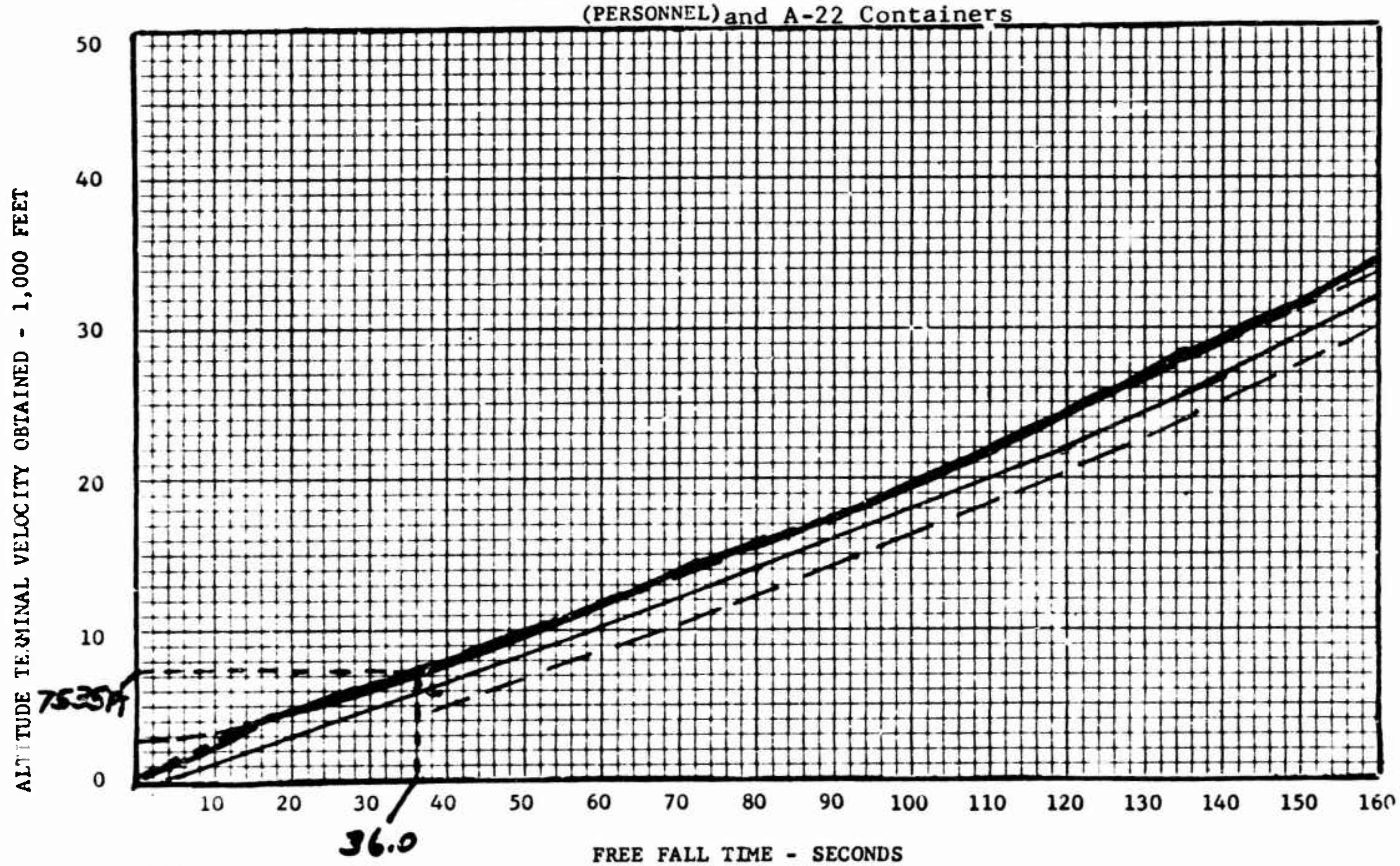
TIME TO TERMINAL VERTICAL VELOCITY
(PERSONNEL) and A-22 Containers



NOTES:
1. Dotted lines indicate maximum and minimum
2. Solid line is average data
3. Standard day temperature data
4. Heavy Dark Line Interim HLCADS

TABLE 3

TIME OF FALL AT TERMINAL VELOCITY
(PERSONNEL) and A-22 Containers



NOTES:
1. Dotted lines indicate maximum and minimum
2. Solid line is average data
3. Standard day temperature data
4. Heavy Dark Line Interim HLCADS

TABLE 4

DROP ALTITUDE

TIME DELAY SELECTION

Time Delay in Sec	Color Code	Absolute Altitude
20	Red	5,000 Ft.
40	Yellow	9,800 Ft.
50	Green	12,800 Ft.
60	Blue	15,800 Ft.
80	Gray	23,300 Ft.